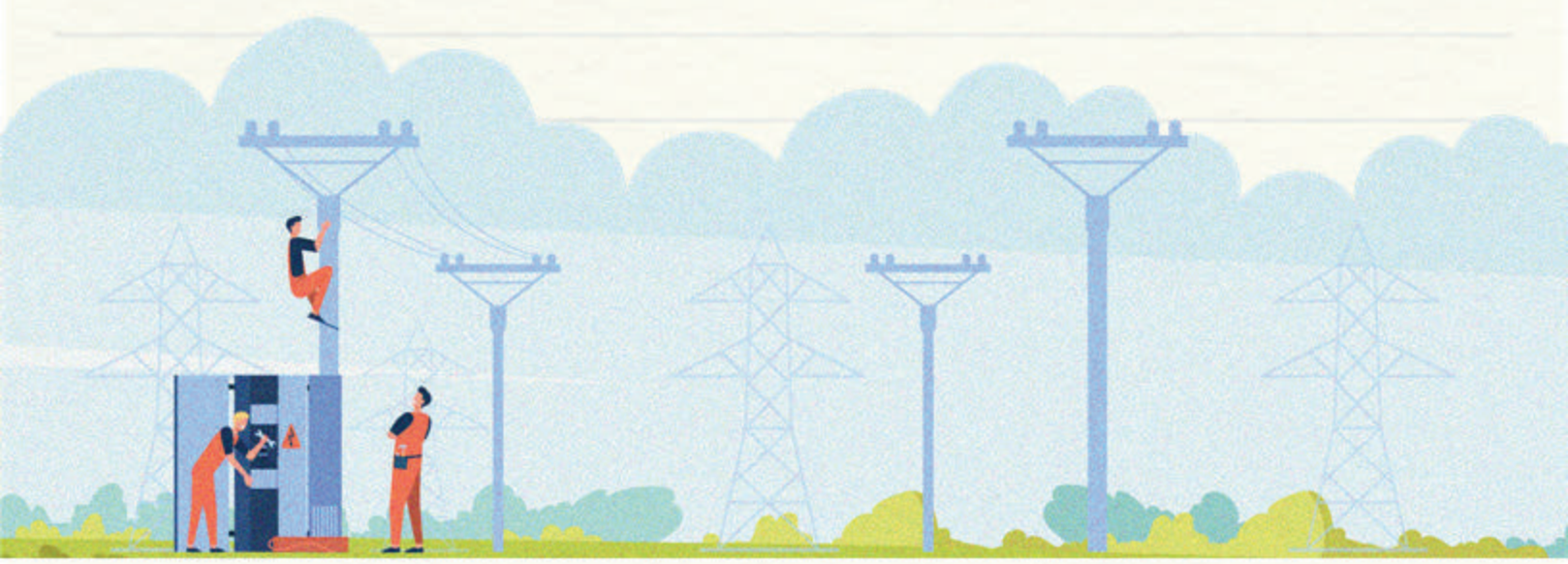
PHYSICS

BYJU'S
POST CLASS NOTES

Electricity

Topics

1. Electric Current
2. Electric Potential
3. Electrical Symbols
4. Ohm's Law
5. Resistance and Resistivity
6. Combination of Resistors
7. Joule's Law of Heating
8. Commercial Unit



1. Electric Current

1.1 Electric Charge (Q) :

- Fundamental property of matter
- Unit: coulomb (C)

Two types of charge

Positive Charge

For proton, charge is:

$q = +e = +1.6 \times 10^{-19}\ C$

Negative Charge

For electron, charge is:

$q = -e = -1.6 \times 10^{-19}\ C$

1.2 Electric Current (I):

- Rate of flow of charge through a cross section.
- SI unit: ampere (A)

$$I = \frac{\text{Electric charge}}{\text{Time}} = \frac{Q}{t}$$

$Q = nq$

n = Number of electrons / protons

2. Electric potential

2.1 Potential Difference (V):

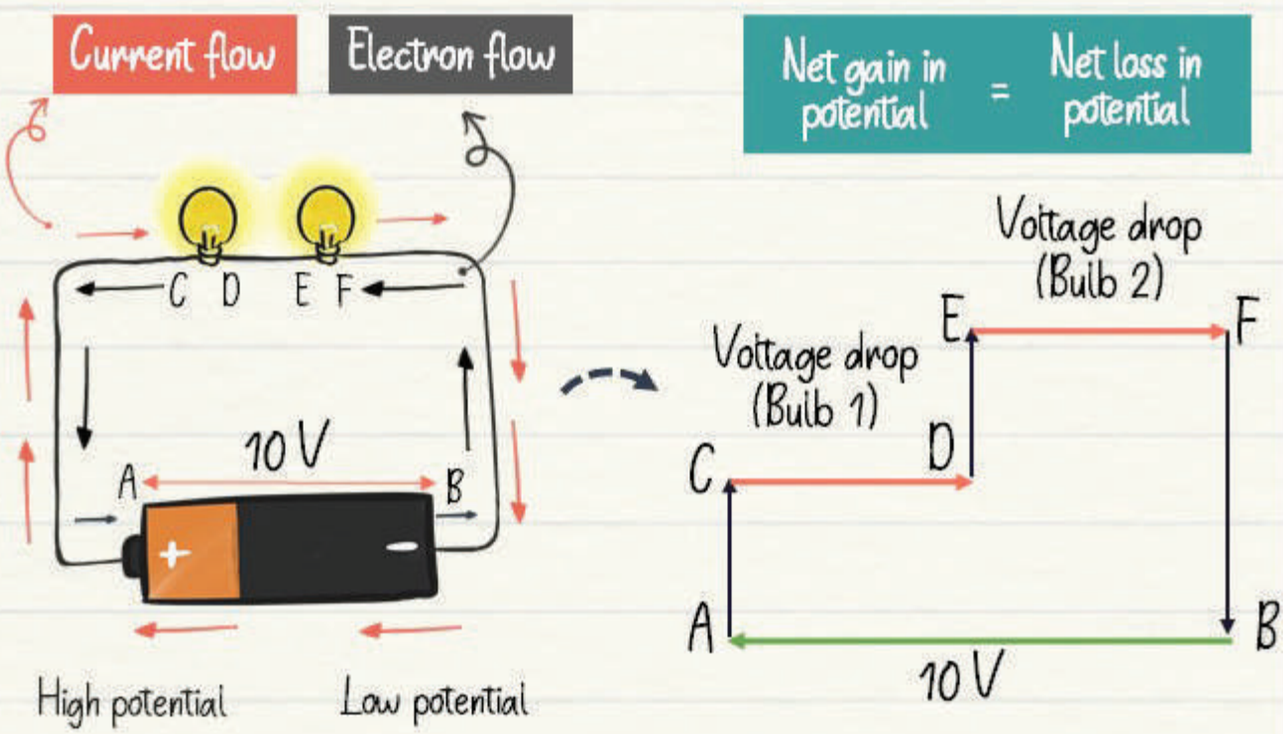
Work done by the external force to move a unit positive charge between two points slowly.

- Unit: volts (V)

$$V = \frac{\text{Work done}}{\text{Charge}} = \frac{W}{q}$$

2.2 Current Flow

- Opposite to electron flow
- From high to low potential in the external circuit.



3. Electric symbols

3.1 Electrical Symbols

Symbols to conveniently represent circuits and their components

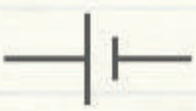
Electric Bulb

Switch On

Switch Off

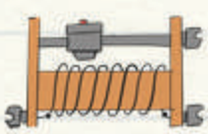
Wire

Cell



Battery

Resistance



Variable resistance

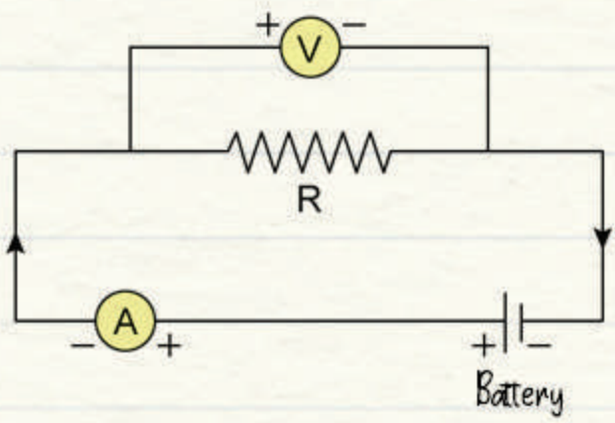
Ammeter

Voltmeter

4. Ohm's Law

4.1 Ohm's Law

For an ohmic resistor, and at constant temperature and pressure, the potential difference across it is directly proportional to the current flowing through it.



$$V = I R$$

where:

V- Voltage (reading on voltmeter)

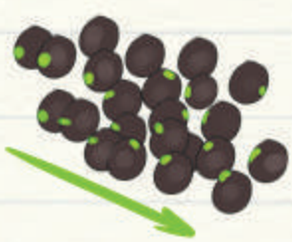
I- Current (reading on ammeter)

R- Resistance

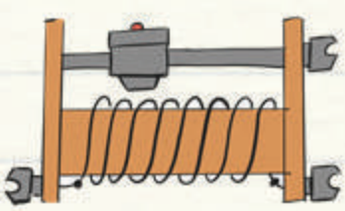
5. Resistance

5.1 Resistance:

- Opposition to flow of current
- SI unit: ohm (Ω)



Fixed Resistance



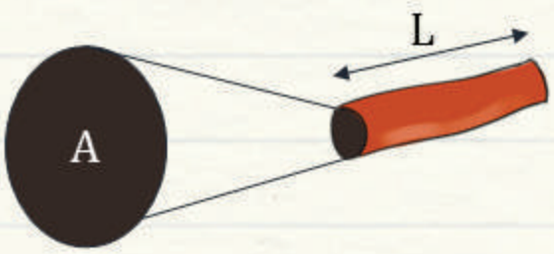
Variable resistance - Rheostat

5.2 Factors Affecting Resistance

Resistance depends on the geometry and the material of the resistor.

$$R = \rho \times \frac{L}{A}$$

L- Length
A- Area
ρ- Resistivity



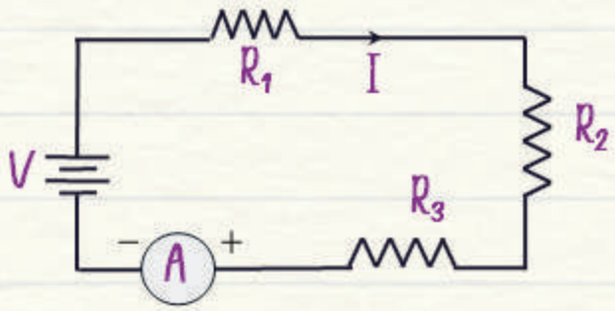
5.3 Resistivity:

- Property of a material to oppose the flow of current at a given temperature and pressure.
- SI unit: (Ω-m)

Resistivity range	Material
10^{-8} to 10^{-6} Ω-m	Good conductor
10^{10} to 10^{17} Ω-m	Poor conductor

b. Combination of Resistors

6.1 Resistors in Series:



$$V = V_1 + V_2 + V_3$$

$$I = I_1 = I_2 = I_3$$

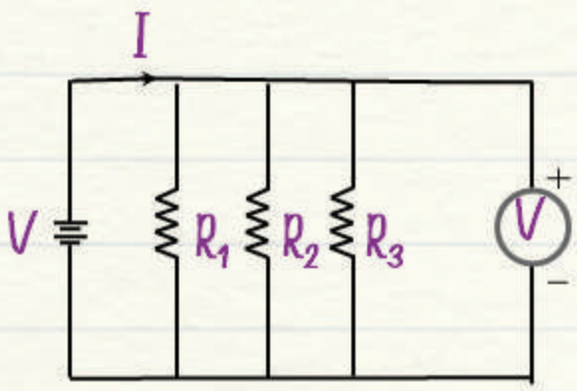
$$R_{eq} = R_1 + R_2 + R_3$$

$$\Downarrow$$

$$R_{eq} > R_i$$

- Failure of one resistor leads to failure of all the resistors.
- Ammeter is connected in series to measure current.
- Ammeter has a very small resistance.

6.1 Resistors in Parallel:



$$V = V_1 = V_2 = V_3$$

$$I = I_1 + I_2 + I_3$$

$$\frac{1}{R_{eq}} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3}$$

$$\Downarrow$$

$$R_{eq} < R_i$$

- Failure of one resistor does not affect other resistors.
- Voltmeter is connected in parallel to measure potential difference.
- Voltmeter has a very large resistance.

7. Joule's law of heating

7.1 Joule's Law:

- Electric current through a resistor produces heat.
- Heat produced in the resistor is directly proportional to:
  - Square of the current flowing
  - Resistance
  - Time for which the current flows

$$H = I^2Rt$$

7.2 Practical Applications

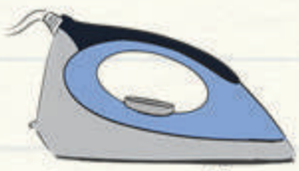
Electric Heater

Electric Geyser

Electric Kettle

Electric Toaster

Electric Fuse



Laundry Iron

8. Commercial unit

8.1 Electrical Power:

- Rate at which energy is consumed or produced in a circuit component.
- S.I Unit : watt (W)

$$P = VI = \frac{V^2}{R} = I^2 R$$

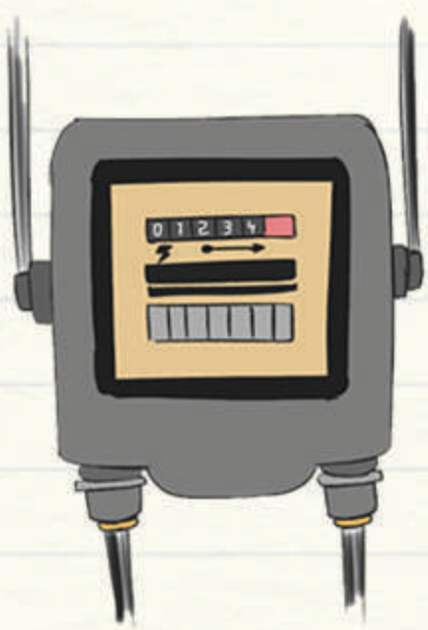
1 watt = 1 volt x 1 ampere

8.2 Commercial unit of energy:

- Unit: kWh (commonly called units)
- Energy = Power x time
- Commercial Unit

1 kWh = 1000 W x 3600 s

= 3.6×10^6 J



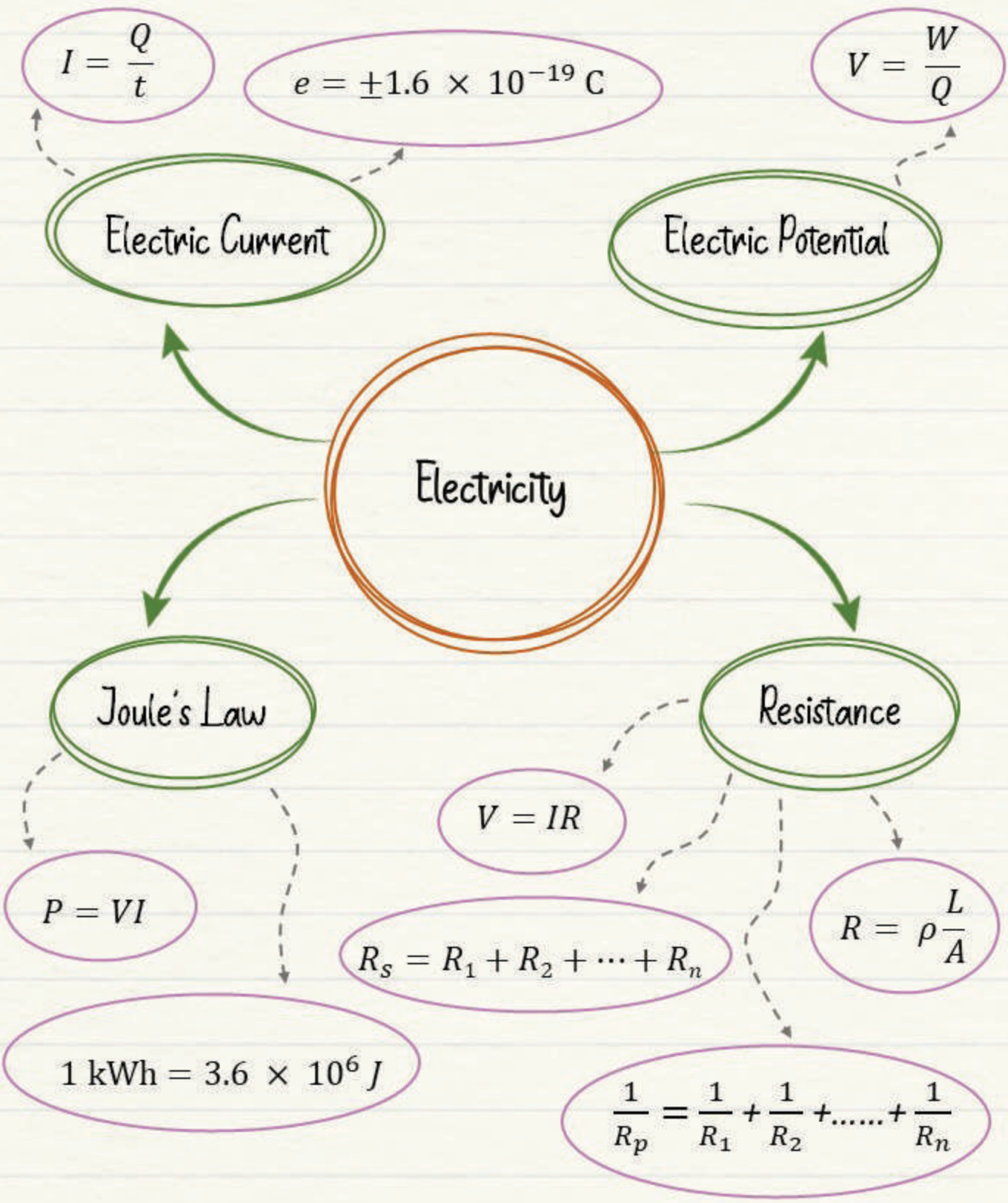
Watt hour meter / Energy meter:
Used to measure the amount of electrical energy consumed by a consumer.

B

Important Formulae

Quantity	Formula (or Value)
Charge on electron Charge on proton	-1.6×10^{-19} C $+1.6 \times 10^{-19}$ C
Electric current	$I = \frac{Q}{t}$
Electric potential difference	$V = \frac{W}{Q}$
Ohm's Law	$V = IR$
Factors affecting resistance	$R = \rho \frac{L}{A}$
Effective resistance in series	$R_s = R_1 + R_2 + \cdots + R_n$
Effective resistance in parallel	$\frac{1}{R_p} = \frac{1}{R_1} + \frac{1}{R_2} + \ldots\ldots + \frac{1}{R_n}$
Electrical power	$P = VI$
Commercial unit of energy	$1\ \text{kWh} = 3.6 \times 10^6$ J

Mind Map


Electricity
Electric Current
$I = \frac{Q}{t}$
$e = \pm 1.6 \times 10^{-19}$ C
Electric Potential
$V = \frac{W}{Q}$
Joule's Law
$P = VI$
$1\ \text{kWh} = 3.6 \times 10^6\ J$
Resistance
$V = IR$
$R_s = R_1 + R_2 + \cdots + R_n$
$R = \rho \frac{L}{A}$
$\frac{1}{R_p} = \frac{1}{R_1} + \frac{1}{R_2} + \ldots\ldots + \frac{1}{R_n}$